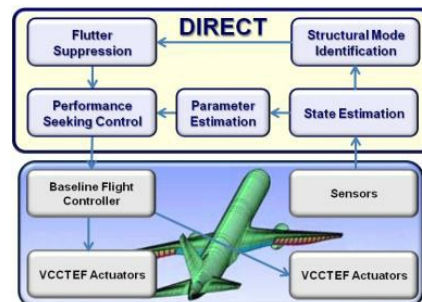# Drag Identification & Reduction Technology (DIRECT) for Elastically Shaped Air Vehicles, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

The Variable Camber Continuous Trailing Edge Flap (VCCTEF) concept offers potential improvements in the aerodynamic efficiency of aircraft through real time wing shaping. NASA and Boeing have been studying the suitability of this concept to address the drag reduction problem in aircraft with reduced-stiffness wings. However, reduced stiffness may lead to wing flutter. In addition, displacements of VCCTEF control surfaces are limited and subject to highly nonlinear and time-varying constraints. Hence control design needs to solve a constrained multi-objective optimization problem. To address these challenges, in Phase I SSCI carried out initial development and testing of the Drag Identification and Reduction Technology (DIRECT). The DIRECT software estimates wing structural modes on-line and uses that information in a robust predictive controller design. Based on using Evolutionary Optimization and off-line analysis, DIRECT estimates wind disturbances on-line and selects optimal controller parameters from a table lookup to achieve on-line drag minimization. Building upon the successful Phase I development, in Phase II we propose to extend the DIRECT approach and evaluate its performance through high-fidelity simulations and wind-tunnel testing. Specific Phase II tasks include: (i) Test Phase I flutter suppression algorithms and PSC algorithms in a GTM simulation with flexible modes and VCCTEF control surfaces; (ii) Extend and enhance the drag minimization approach by developing innovative Performance Seeking Control (PSC) algorithms; and (iii) Compare the features of PSC and other available performance seeking control algorithms through wind-tunnel testing at the University of Washington Aerodynamics Laboratory (UWAL). Professor Eli Livne of University of Washington and Mr. James Urnes, Sr. will provide technical support under the project. Phase III will focus on commercialization of SYMPTOM software to manned aircraft and UAS.
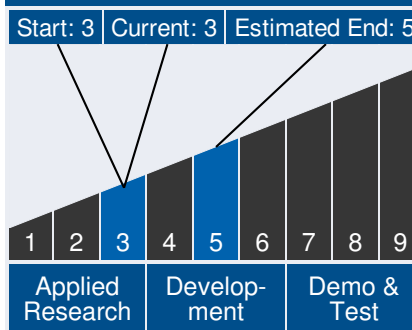
Drag Identification & Reduction Technology (DIRECT) for Elastically Shaped Air Vehicles

Table of Contents

Technology Maturity

Start: 3 | Current: 3 | Estimated End: 5

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Applied Research | Development | Demo & Test

Management Team

Program Executives:
- Joseph Grant
- Laguduva Kubendran

Continued on following page.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: The proposed DIRECT system is consistent with the main objectives of the NASA N+3 Concept Aircraft Project. In particular, it addresses the problem of flutter identification and suppression, while simultaneously achieving drag reduction using performance-seeking control algorithm. Hence the proposed DIRECT system can be used in future designs of HALE UAVs with flexible wings. The use of the DIRECT technology in this context would help in lowering the costs of NASA scientific research by reducing fuel consumption, and in contributing to environmental protection by lowering emissions and noise.

To the commercial space industry:

Potential Non-NASA Commercial Applications: The proposed DIRECT system is applicable to future flexible-wing commercial vehicle concepts where the main objective is to enhance fuel efficiency while reducing noise and emissions. The approach will also be applicable to military aircraft with elastic wings.

Management Team *(cont.)*

Program Manager:
- Carlos Torrez

Principal Investigator:
- Jovan Boskovic

Technology Areas

Primary Technology Area:
Aeronautics (TA 15)
└ Ultra-Efficient Commercial Vehicles (TA 15.3)
  └ Achieve Community Goals for Improved Vehicle Efficiency and Environmental Performance in 2025 (TA 15.3.1)
    └ Demonstrate Innovative Flow Control (TA 15.3.1.1)

Secondary Technology Area:
Modeling, Simulation, Information Technology and Processing (TA 11)

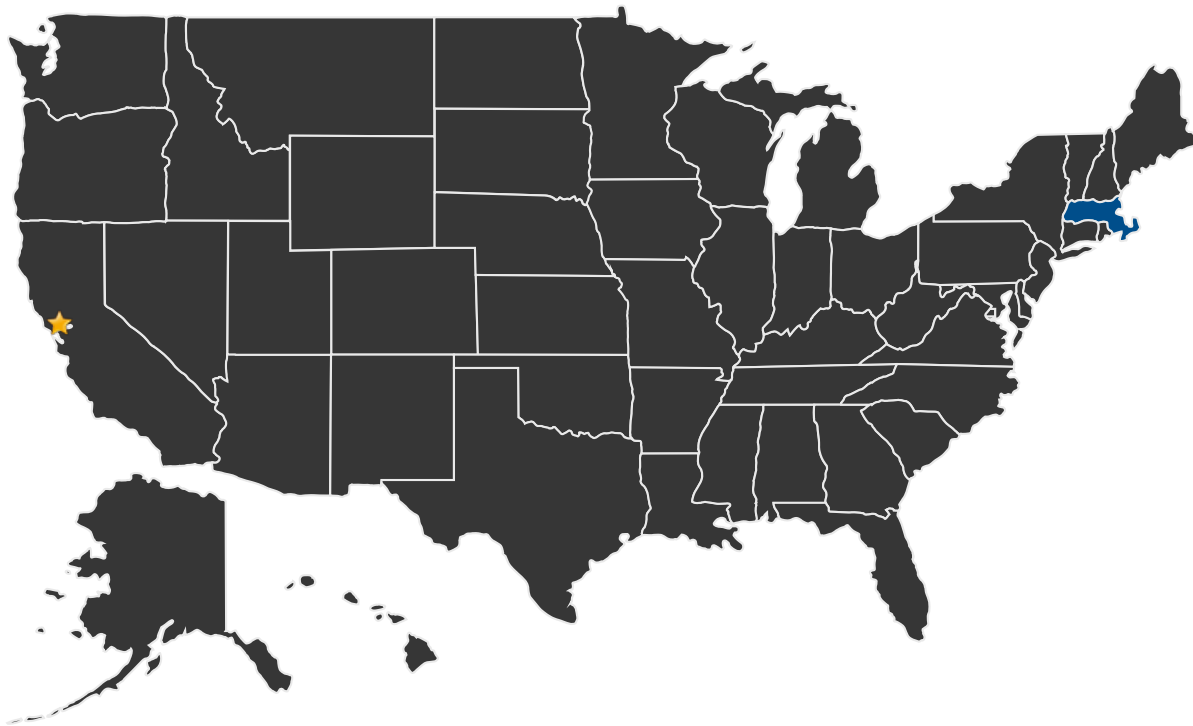**Additional Technology Areas:**
Aeronautics (TA 15)
└ Ultra-Efficient Commercial Vehicles (TA 15.3)

Drag Identification & Reduction Technology (DIRECT) for Elastically Shaped Air Vehicles, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

U.S. WORK LOCATIONS AND KEY PARTNERS

■ U.S. States With Work ⭐ **Lead Center:**
Ames Research Center

Other Organizations Performing Work:

- Scientific Systems Company, Inc. (Woburn, MA)

PROJECT LIBRARY

Presentations

- Briefing Chart
    - (http://techport.nasa.gov:80/file/17965)

DETAILS FOR TECHNOLOGY 1

Technology Title

Drag Identification & Reduction Technology (DIRECT) for Elastically Shaped Air Vehicles